Union of Concerned Scientists

Citizens and Scientists for Environmental Solutions

TESTIMONY SUBMITTED BY

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TO THE SELECT COMMITTEE ON

ENERGY INDEPENDENCE AND GLOBAL WARMING

UNITED STATES HOUSE OF REPRESENTATIVES

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Mr. Chairman and members of the Subcommittee, on behalf of the Union of Concerned Scientists (UCS), I appreciate this opportunity to present our views on nuclear power's past, present, and future.

My name is David Lochbaum. After obtaining a degree in nuclear engineering from the University of Tennessee in 1979, I worked for over 17 years in the nuclear power industry, mostly at operating reactors in Georgia, Alabama, Mississippi, Kansas, New Jersey, Pennsylvania, New York, Ohio and Connecticut. I joined UCS in October 1996 and am the Director of the Nuclear Safety Project. Almost from its inception in May 1969, UCS has worked to enhance nuclear power plant safety and security. UCS is neither an opponent nor a supporter of nuclear power–our perspective is that of a safety and security advocate.

Global warming is UCS's foremost concern. If we fail to do the right thing about global warming, then solving other problems becomes moot. UCS recently re-examined nuclear power's role in combating global warming. We concluded that an expansion of nuclear power could help curb global warming because nuclear power plants do not emit global warming gases during operation and the emissions during the nuclear fuel cycle and plant construction are relatively modest.

Unfortunately, history has repeatedly shown that the safety and security risks of this nuclear curb are both significant and sustained. Those advocating a nuclear revival should recall the famous words of George Santayana: *Those who cannot learn from history are doomed to repeat it.* Here is the nuclear power history we risk repeating:[1]

[1] Data Sources: United States Council on Energy Awareness, "Historical Profile of U.S. Nuclear Power Development," 1993 Edition; United States Nuclear Regulatory Commission, "2006-2007 Information Digest," NUREG-1350 Vol. 18, August 2006; and Union of Concerned Scientists, "Walking a Nuclear Tightrope: Unlearned Lessons of Year-plus Reactor Outages," September 2006.

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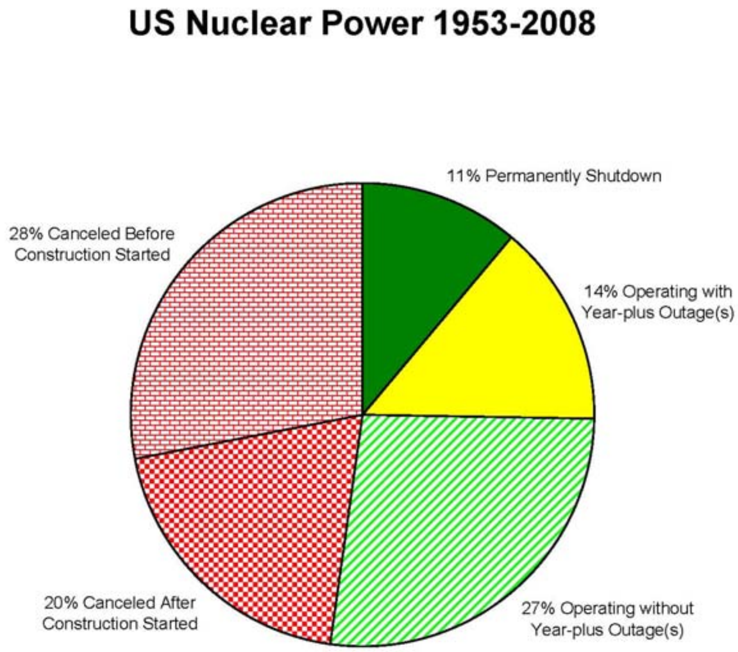
U.S. Nuclear Power Reactors, 1953-2008

253	nuclear power reactors ordered
71	reactors canceled before construction started
182	construction permits or limited work authorizations issued
50	reactors canceled after construction started
132	operating licenses issued
28	reactors permanently shut down before the end of their 40-year operating licenses expired (including one meltdown)
104	reactors operating
36	reactors operating despite having experienced one or more year-plus outages
68	reactors operating having never experienced a year-plus outage
0	inherently safe reactors operating



The last entry in the table–which indicates that none of the operating reactors are inherently safe–may appear to be a snide editorial comment, but is not. Because the reactors are inherently dangerous, their risk must be properly managed. The history of nuclear power in the United States is fraught with mismanagement of that risk. This has resulted in reactors that were canceled before ever operating, permanently shut down before the end of their operating licenses, and temporarily shut down for over a year to restore safety levels. This mismanagement of these inherently dangerous reactors made nuclear power less safe and more costly than necessary.

While it has been several decades since the last nuclear power reactor was ordered in the United States, the nuclear industry did not use that time to design inherently safe reactors, or even reactors that are vastly safer than those operating today. It is for this reason that the 2005 Energy Bill extended federal liability protection for nuclear power reactors via the Price-Anderson Act, as amended. Because the new reactor designs do not provide inherent or significantly enhanced safety, they are as vulnerable to mismanagement as are current reactors.

Nor did the nuclear industry and the NRC use the past several decades to improve management and oversight performance and thus exorcise safety problems caused by mismanagement. (Attachment 1 contains a sampling of mismanagement case studies including the current one involving the Palo Verde Unit 3 nuclear reactor in Arizona.) The nuclear industry itself believes that mismanagement can be as big a problem in the future as it has been in the past. It is for this reason that the 2005 Energy Bill provided federal loan guarantees to new reactors, protecting investors in the event that reactors under construction default on debt payments.

During the 97th Congress, the House Subcommittee on Energy and the Environment of the Committee on Interior and Insular Affairs held an oversight hearing on November 19, 1981, titled "Quality Assurance in Nuclear Powerplant Construction." Chairman Morris K. Udall summarized construction problems caused by poor quality control at the Diablo Canyon (CA), South Texas Project (TX), and Zimmer (OH) nuclear plants and posed four questions:

1. How did these quality assurance failings occur?

2. Why did these failings go so long undetected by the owner utilities and the NRC?

3. What is being done to minimize the likelihood of future failings of this kind?

4. How are we to be sure that completed plants have in fact been constructed in accordance with the Commission's regulations?

As the case studies in attachment 1 indicate, the answer to the first question is "mismanagement by the plant owners." The recurring theme in nuclear plant problems since 1981 has been mismanagement. Mismangement shut down all of TVA's operating nuclear plants for many years in the mid 1980s and early 1990s. Mismanagement shut down the Salem (NJ), Millstone (CT), Clinton (IL), Crystal River Unit 3 (FL) and DC Cook (MI) reactors for over one year in the late 1990s. Mismanagement shut down Davis-Besse (OH) for over two years in the early part of this decade. Mismanagement caused the current problems at Palo Verde (AZ).

As the case studies indicate, the answer to question 2 is "mismanagement by the plant owners and ineffective oversight by the NRC." The companion theme in nuclear plant problems since 1981 has been ineffective oversight by the NRC. An evaluation by the General Accounting Office (GAO) of NRC's oversight of the Millstone, Salem, and Cooper (NE) nuclear plants concluded:[2]

NRC is Not Effectively Overseeing the Plants That Have Problems
and
NRC is Not Getting Licensees to Fix Deficiencies in a Timely Manner
and
NRC Enforcement Actions Are Too Late to Be Effective

Seven years later, almost to the day, the GAO reported on its assessment of NRC's oversight of the Davis-Besse nuclear plant concluded:[3]

> *NRC should have but did identify or prevent the vessel head corrosion at Davis-Besse because both its inspections at the plant and its assessments of the operator's performance yielded inaccurate and incomplete information on plant safety conditions.*

and

[2] US General Accounting Office, 1997. "Nuclear Regulation: Preventing Problem Plants Requires More Effective NRC Action," GAO/RCED-97-145. Pages 10 and 14. May.
[3] US General Accounting Office, 2004. "Nuclear Regulation: NRC Needs to More Aggressively and Comprehensively Resolve Issues Related to the Davis-Besse Nuclear Power Plant's Shutdown," GAO-04-415.

NRC's process for deciding whether Davis-Besse could delay its shutdown to inspect for nozzle cracking lacks credibility because the guidance NRC used was not intended for making such a decision and the basis for the decision was not fully documented.

The names and dates may change, but the underlying pattern of mismanagement coupled with ineffective oversight stays the same.

The answer to question 3 is that the likelihood of quality assurance failings during nuclear plant construction was minimized when we stopped constructing nuclear power plants. No nuclear power plant construction efforts were initiated after this hearing and the last of those underway at the time of the hearing saw the Watts Bar Unit 1 reactor begin operating in 1996. We never solved the problem, it simply became moot.

The answer to question 4 is that no such assurance exists, as irrefutably demonstrated by the NRC's report on its efforts responding to design errors exposed at Millstone (CT).[4] Figure 1 from the NRC's report shows that hundreds of design errors–*prima facie* evidence that completed plants did not meet NRC's regulations–reported annually, a high number given that only slightly over 100 nuclear power reactors are operating. Figure 10 from the NRC's report revealed that 70 percent of the hundreds of design errors dated back to original construction. Figure 10 also revealed that whatever remedies promised to Congress as a result of the 1981 hearing were either not implemented or not implemented effectively. More than 10 percent of the design errors were introduced by "plant modifications," changes to the plants generally made after they began operating.

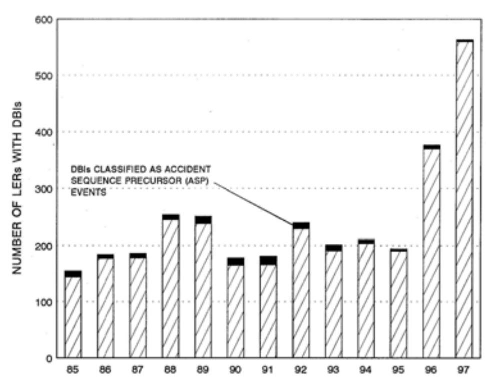


Figure 1 Trend of design basis issues reported for 1985–1997

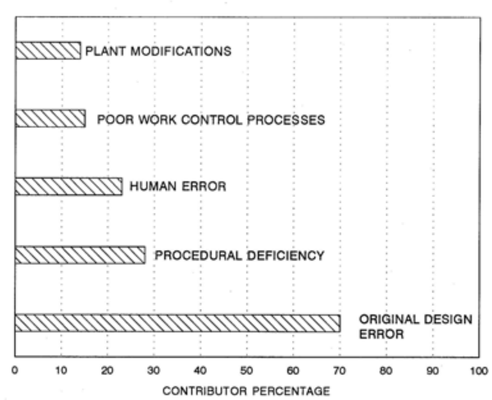


Figure 10 Causes of design-basis issues for 1997

[4] Nuclear Regulatory Commission, 2000. "Causes and Significance of Design-Basis Issues at U.S. Nuclear Power Plants," NUREG-1275, Vol. 14. November. Available in NRC's online ADAMS library under accession no. ML003773633.

But what does nuclear power's past 55 years have to say about nuclear power's future? The NRC anticipates receiving applications to construct and operate 33 nuclear power reactors through 2010.[5] If this happens, running the calendar 55 years forward to 2063 could yield the following "retrospective:"

New U.S. Nuclear Power Reactors, 2008-2063?

33	nuclear power reactors ordered
9	reactors canceled before construction started
24	combined operating licenses issued
7	reactors canceled after construction started
17	reactors placed into operation
4	reactors permanently shut down before the end of their 40-year operating licenses expired
13	reactors operating
4	reactors operating despite having experienced on or more year-plus outage(s)
9	reactors operating without having experienced a year-plus outage(s)
0	inherently safe reactors operating

If the nuclear revival turns out to be merely a nuclear re-run, the multi-billion dollar investment in 33 nuclear power reactor solutions to the global warming dilemma would result in 13 operating reactors, only 9 of which would have avoided year-plus outage(s) to restore deficient safety levels.

There are ample signs that neither the nuclear industry nor the NRC has taken the steps needed to prevent a nuclear re-run. While no new nuclear reactors have been constructed in the United States in decades, modifications to existing nuclear reactors have occurred in recent years. The fact that the nuclear industry, and its regulator, cannot renovate a small portion of a nuclear power reactor without compromising safety provides zero confidence that they will be able to design, build, and operate new reactors any better. A very abridged list of many recent modifications gone awry:

> **Quad Cities (IL)**: The Atomic Energy Commission issued operating licenses for the two reactors in December 1972. Twenty-nine years later, the NRC approved amendments to the licenses that increased the maximum power level of the reactors by 20 percent. In March 2002, the Unit 2 reactor was operated at the uprated power level for the first time. Within about three weeks, the reactor had to be shut down to repair leaks in the turbine control system caused by vibrations from the higher steam flow rates. As the reactor was being restarted after these repairs, vibrations broke a drain line off one of the major steam pipes. There had been earlier warnings about excessive vibrations because when–of all things–a vibration monitor shook itself loose from the piping and fell to the floor. Workers patched the broken drain lines and restarted the reactor without having corrected the vibration problems. Within weeks, the reactor had to shut down again when vibrations damaged a large metal component called the steam dryer located above the reactor core. The reactor's owner reported:

[5] Nuclear Regulatory Commission webpage http://www.nrc.gov/reactors/new-licensing/new-licensing-files/expected-new-rx-applications.pdf, February 27, 2008.

The root cause of the steam dryer failure was determined to be a lack of industry experience and knowledge of flow-induced vibration dryer failures.[6]

The inexperience and incomplete knowledge did not end when the broken steam dryer was repaired. Excessive vibrations later damaged two safety relief valves for the Unit 1 reactor. The Quad Cities reactors started up in the 1970s. If the nuclear industry is inexperienced and knowledge-challenged three decades later about how these reactors work, why would any reasonable person believe the industry would possess sufficient experience and knowledge to tinker with new reactors?

Palo Verde (AZ) and Waterford (LA): In fall 2004 and spring 2005, workers at the Palo Verde Unit 3 reactor and Waterford reactor replaced the electric heaters inside the pressurizers. Due to failure of the replacement heaters, Palo Verde Unit 3 had be shut down several times over the next few months. The faulty replacements had to be replaced at Waterford even sooner. The NRC reported:

The vendor subsequently inspected the failed heaters from the Palo Verde and Waterford plants and determined that the heaters had been incorrectly fabricated with a longer heating element than the licensees' design specification.[7]

There's scant evidence to suggest performance with new reactors will be the same as in the past, yet alone to believe it will be better. At an April 17, 2007, Commission briefing on new reactors, I asked how the NRC intended to train its existing staff and its many new hires on nuclear plant construction oversight, an activity not performed by the NRC in over a decade. I expected to hear about the role of the NRC's Technical Training Center in Tennessee. Instead, all I heard about was on-the-job training: Joe will tell Mary who will tell Ludwig who will pass it along to Brendan and Alexa. It would be insanity, if it wasn't pre-planned and deliberate.

More troubling is NRC's fixation or obsession with schedule rather than quality. The NRC Commissioners' testimony before Congress, pledges before industry, and interviews for media exclusively focus on their plans to approve new reactor licenses within 24 months. How does NRC plan to meet its set-in-stone schedules? By farming out its safety review work to private industry.[8] That's quite simply outrageous and unacceptable. As Congressman Edward Markey quite correctly pointed out in his September 24, 2007, letter to NRC Chairman Dale Klein:

If Congress has intended to allow private companies to regulate private companies in the extraordinary sensitive nuclear sector, we would not have established the NRC.

Neither the nuclear industry nor the NRC can provide sufficient evidence to prove that mismanagement and ineffective oversight problems have been properly addressed.

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[6] Union of Concerned Scientists, 2004. "Snap, Crackle & Pop: The BWR Power Uprate Experiment." July 9. Available online at http://www.ucsusa.org/clean_energy/nuclear_safety/snap-crackle-pop-experimental-power-uprates-at-boiling-water-reactors.html

[7] Nuclear Regulatory Commission, 2006. "Design Deficiency in Pressurizer Heaters for Pressurized-Water Reactors," Information Notice No. 2006-04. February 13. Available online at http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/2006/in200604.pdf

[8] Washington Business Journal, 2007. "Firm's Rockville site to handle contract on nuclear plant analysis." September 17.

The Energy Bill of 2005 contains billions of dollars of taxpayer subsidies intended to jump start a moribund nuclear power industry under the thin guise of helping to address global warming. The subsidies come in the form of loan guarantees to cover debts when nuclear plants are canceled during construction, cost containment measures to cover construction taking longer than planned, and liability protection to cover offsite damages and deaths due to a nuclear reactor disaster. Nuclear power reactor owners are thus protected if their mismanagement causes a reactor under construction to be canceled, a reactor under construction to take longer and cost more to reach completion, or a reactor under operation to melt down, but how are Americans protected from global warming when this mismanagement results in nuclear power's "solutions" coming up empty?

Clearly, the American public deserves protection against the nuclear industry defaulting on its global warming pledges, especially since so many of their tax dollars are underwriting the industry's pledges. The best public protection would be a zealously aggressive regulator that consistently and effectively enforced federal safety regulations. Such a regulator would prevent the significant degradation that doomed the Zimmer (OH) and Shoreham (NY) plants, prematurely shut down the Rancho Seco (CA) and Fort St. Vrain (CO) reactors, and caused low safety/high cost operations at Millstone (CT), Davis-Besse (OH), and Palo Verde (AZ). These and numerous other shortfalls show that enough is not being done to minimize the safety risks of nuclear power today, and that the NRC is not the regulator it needs to be to manage the risks of tomorrow.

Consider the event widely deemed to be the closest near-miss since the 1979 meltdown at Three Mile Island–the March 2002 discovery of a football-sized hole in the reactor vessel at Davis-Besse. The NRC expended nearly 7,000 person-hours[9] examining things it could have done to prevent this near-miss. That self-assessment resulted in 49 recommendations on process changes to prevent future near-misses. Ninety-four percent of those recommendations involved ways the NRC could better enforce existing federal regulations. In other words, the underlying regulations were sufficient to have prevented the Davis-Besse near-miss had the NRC merely enforced them. NRC's lack of enforcement was contributed to seriously degraded safety levels at dozens of nuclear power reactors in the US. For decades, the NRC has been a poor enforcer of federal safety regulations. If accused of being an effective regulator, the NRC could not be convicted.

If NRC's performance deficiencies are not rectified, the future of nuclear power will be less safe and more costly than necessary. One need not gaze into a crystal ball to divine this outlook, looking into the rear-view mirror at Zimmer (OH), Watts Bar (TN), Millstone (CT), and Davis-Besse (OH) is enough.

Luckily, the key to successful reforms at the NRC is also readily visible in that rear-view mirror. The mismanagement that created the problems at Watts Bar, Millstone, and Davis-Besse were resolved by bringing in new managers. Not by pruning senior managers and bumping everyone else up one rung on the ladder; but by bringing in senior managers who could set high performance standards and institute the policies and practices needed to attain and then sustain those standards.

[9] By comparison, the NRC expended an average of only 5,003 person-hours inspecting safety at each nuclear plant site in fiscal year 2002. (source: NRC SECY-07-0069 dated April 6, 2007). An effective regulator would spent more effort ensuing safety than explaining its shortcomings.

Beset by the same mismanagement woes that infested these reactors, NRC waits for attrition to remove its senior managers, bumps everyone else up on rung on the ladder and hires new people at ground-level entry positions. This process sustains the status quo at NRC and explains why it continues to do a poor job enforcing its own regulatory standards.[10]

The NRC must take three immediate towards becoming the enforcer of federal safety regulations the American public deserves:

1. Institute safety culture surveys of the NRC work force every two years and make the survey results publicly available.

2. When NRC senior manager vacancies from a pool that includes external candidates.

3. Initiate a rotation plan in which NRC mid-level managers work for approximate one year periods at other federal agencies (i.e., DOE, EPA, NASA, FEMA, etc.) and mid-level managers from those agencies work at the NRC, for about a year. In this way, NRC managers would learn new management skills, and the NRC would receive input on regulatory and safety management approaches from other agencies.

This hearing is titled “Nuclear Power in a Warming World: Solution or Illusion?”

If the NRC is not reformed, even existing reactors may not operate long into the future and new reactors are unlikely to make a meaningful contribution to global warming. Thus, if the NRC is not reformed, UCS believes that nuclear power will be more of an illusion than a solution.

Attachments:

1) Case Studies of Nuclear Reactor Mismanagement

2) Executive summary from UCS’s December 2007 report *Nuclear Power in a Warming World*. The full report is available online at
http://ucsusa.org/global_warming/solutions/nuclearandclimate.html

3) Curriculum vitae

[10] The recent debacle over Wackenhut security guards sleeping at Exelon’s Peach Bottom nuclear plant vividly illustrates the NRC’s fundamental problem. Subsequent investigations revealed that Wackenhut, Exelon, and Peach Bottom all knew about the problem for months before a TV reporter exposed it. The sleeping guards have been fired. Wackenut lost its contract at Peach Bottom and all other Exelon nuclear plant sites. Exelon brought in new managers to govern security at Peach Bottom. But no one at NRC lost a job or even received a finger-shaking scolding for the agency’s culpability in the debacle.

Attachment 1 – Case Studies of Nuclear Reactor Mismanagement

CANCELED AFTER CONSTRUCTION STARTED

Zimmer (OH): The Atomic Energy Commission issued a construction permit in October 1972. In September 1978, the US General Accounting Office issued a report criticizing NRC's inspection program for reactors under construction. In January 1979, a private investigator reported safety defects. NRC investigated and in July 1980 cited the company for sloppy paperwork but found its work to be otherwise sound. In December 1980, the Government Accountability Project initiated a follow-up probe into the safety defects identified by the private investigator. NRC conceded in August 1981 that its first investigation into safety concerns was inadequate and fined the company $200,000 in November 1981 for poor quality control. In June 1982, the US House held hearings on construction problems at Zimmer and the U.S. Attorney confirmed it was investigating reports that quality assurance inspectors at the plant were being harassed and intimidated. In December 1982, Congressman Morris Udall stated that NRC misled the public about conditions at Zimmer by "*squelching NRC documents critical of the plant*." In August 1983, an independent consulting firm hired by the company reported that the problems caused by "*a total management breakdown*" could be fixed. On January 21, 1984, the company announced that Zimmer would be converted to a coal-fired generating station. The cost of this 'nuclear' plant was over $1 billion in 1980 dollars.[11]

Shoreham (NY): The Atomic Energy Commission issued a construction permit in April 1973. The reactor's original cost was estimated to be $65 million (1970 dollars). By May 1974 after one year of construction, the estimated cost had increased to $695 million. The estimated cost neared $1 billion by the end of 1976. Approximately $100 million of the cost increase was due to the need to re-design and re-build the GE Mark II containment when the NRC revised requirements in 1975. An audit by New York State in 1984 concluded that the company failed to properly schedule and monitor construction work, resulting in the waste of almost 10 million man-hours, about one-third of the labor invested in the plant. In March 1984, cost over-runs forced the company to halt dividend payments and lay-off nearly 1,000 workers. In May 1988, the company and the state agreed to permanently close the $5.5 billion reactor that never really operated.[12]

Midland (MI): The Atomic Energy Commission issued a construction permit in December 1972. At the time, the cost of the two-reactor plant was estimated at $776 million. In July 1978, engineers discovered that the building housing the emergency diesel generators was sinking into the soil. In December 1979, the NRC halted all safety-related work at the site due to the soil settlement problems. The estimated cost of the plant was revised to $3.1 billion. In April 1983, the NRC ordered a complete inspection of work performed to date due to widespread and recurring quality control problems. In October 1983, the company halted construction and laid off 1,000 workers due to confusion over blueprints. The following month, one of the reactors was canceled. In May 1984, the company proposed capping the cost to the ratepayers from the $4.1 billion nuclear plant at $3.5 billion. The offer was

[11] Cincinnati Enquirer, 1984. "Zimmer: Conversion to Coal, A Chronology, 1968-1984." January 22.
[12] Associated Press, 1988. "Chronology of LILCO History." May 26, and Kinsey Wilson, 1992. "Lights out for Shoreham." *Bulletin of the Atomic Scientists*. June.

rejected because even that cap was projected to increase electricity prices by 75 percent. In July 1984, the company canceled the second unit.[13]

Washington Nuclear Plant Units 4 & 5 (WA): The NRC issued construction permits for Units 4 and 5 in April and February 1978, respectively. The company notified the NRC in February 1982 that it was canceling the two reactors with 24 percent and 15 percent of the construction completed, respectively. On July 25, 1983, the company announced it was defaulting on loan payments for $2.25 billion debt for Units 4 and 5. [14]

PREMATURELY SHUT DOWN

Rancho Seco (CA): The Atomic Energy Commission issued a construction permit in October 1968 and an operating license in August 1974. The reactor exhibited a checkered operating history. In April 1989, the Institute of Nuclear Power Operations (INPO) reported to the company's Board of Directors that "*the history of governance and the present governance situation, if unchanged, portend a continuing pattern of performance problems*." In June 1989, the majority of votes in a public referendum were to permanently close the reactor. On June 7, 1989, the reactor was permanently shut down.[15]

Fort St. Vrain (CO): The Atomic Energy Commission issued an operating license in December 1973. The reactor exhibited a checkered operating history before being permanently shut down in August 1989. The reactor had been shut down for nearly two years between June 23, 1984, and April 11, 1986, to restore safety levels. Over its abbreviated operating history, the reactor's top performing month resulted in a 73 percent capacity factor.[16]

Yankee Rowe (MA): The Atomic Energy Commission issued a construction permit in November 1957 and an operating license in July 1960. In 1990, the reactor became the first pressurized water reactor in the United States to initiate a process to extend the original 40-year operating license for an additional 20-year period. On June 5, 1991, UCS petitioned the NRC to order the reactor to be immediately shut down due to unresolved concerns about weakening of the reactor vessel caused by embrittlement. The NRC denied the UCS petition 21 days later. Six New England congressmen formally asked the NRC Commission to review the NRC staff's decision. On July 31, 1991, the Commission affirmed the staff's denial of the UCS petition and authorized reactor operation until April 15, 1992, while the embrittlement concerns were resolved. On October 1, 1991, the NRC staff reversed itself and recommended that the reactor be immediately shut down due to rector vessel embrittlement concerns. The

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[13] *Saginaw News*, 1984. "Consumer Power Co.'s Midland Nuclear Plant has gone through many changes through the years. Here's a chronology of the plant's troubled history." July 17.
[14] R. L. Ferguson, 1982. Letter to William J. Dircks, Executive Director for Operations, Nuclear Regulatory Commission, "Termination of Supply System Nuclear Projects 4 and 5." Ferguson was managing director of the Washington Public Power Supply System. February 1; and Tamar Lewin, 1983. "Power group says it cannot pay off $2.25 billion debt," *New York Times*. July 26.
[15] Zack T. Pate, 1989. Letter to the Sacramento Municipal Utility District Board of Directors. Zack Pate was president of the Institute of Nuclear Power Operations. April 4; and Sacramento Municipal Utility District, 2006. License Termination Plan, Rev. 0. April.
[16] D. A. Copinger and D. L. Moses, 2004. "Fort Saint Vrain Gas Cooled Reactor Operational Experience," NUREG/CR-6839. D. A. Copinger and D. L. Moses work at the Oak Ridge National Laboratory. January; and Nuclear News, 1989. "Fort St. Vrain Has Generated Its Last Electricity." September.

company voluntarily shut down the reactor that same day.[17] In February 1992, the company informed the NRC that it would not be restarting the reactor.

OPERATING REACTORS THAT HAVE EXPERIENCED ONE OR MORE YEAR-PLUS OUTAGES

Millstone Units 2 & 3 (CT): The Atomic Energy Commission issued construction permits for Units 2 and 3 in December 1970 and August 1974 respectively. The NRC issued operating licenses for Units 2 and 3 in September 1975 and January 1986, respectively. Unit 2 was shut down for over three years between February 20, 1996, and May 11, 1999, to restore safety levels. Unit 3 was shut down for over 2 years between March 30, 1996, and July 1, 1998, to restore safety levels. Two researchers at the Yale School of Management examined the Millstone outages and concluded:

> *Executive management treated cost containment and safety related outlays in nuclear plant operations as tradeoffs and deliberately chose the low-cost/low-safety option. That is, they were far from incompetent in choosing an option that contained an inherent risk of NRC shutdown.*[18]

Davis-Besse (OH): The Atomic Energy Commission issued a construction permit in March 1971 and the NRC issued an operating license in April 1977. The reactor was shut down for one and a half years between June 9, 1985, and December 24, 1986, to restore safety levels. The NRC reported the cause of the problems was "*the licensee's lack of attention to detail in the care of plant equipment. The licensee has a history of performing troubleshooting, maintenance and testing of equipment, and of evaluating operating experience related to equipment in a superficial manner and, as a result, the root causes of problems are not always found and corrected*."[19] The reactor was shut down for more than two years between February 16, 2002, and March 16, 2004, to restore safety levels. The company told the NRC that the cause of the problems was "*There was a focus on production established by management, combined with taking minimum actions to meet regulatory requirements, that resulted in the acceptance of degraded conditions*."[20]

OPERATING REACTORS THAT HAVE NEVER EXPERIENCED A YEAR-PLUS OUTAGE

Watts Bar (TN): The Atomic Energy Commission issued a construction permit in January 1973 and the NRC issued an operating license in February 1996 (not a typo, it really took the Tennessee Valley Authority nearly a quarter century to construct this nuclear reactor with its 40-year operating lifetime). The delays were caused, in large part, by management's failure to control the quality of construction work activities. On December 19, 1985, TVA's Nuclear Safety Review Staff reported to the NRC's Commissioners about eleven problem areas, finding that the common thread was non-compliance with the federal quality assurance regulations embodied in 10 CFR Part 50, Appendix B. On January 3, 1986, the NRC asked

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[17] *Boston Globe*, 1991. "Chronology of Yankee Rowe." October 2.

[18] Paul W. MacAvoy and Jean W. Rosenthal, 2001. "The Strategic Destruction of Northeast Utilities." Yale School of Management. April.

[19] Hugh L. Thompson Jr., 1985. Letter to Toledo Edison Company, "Loss of Main and Auxiliary Feedwater Event at the Davis-Besse Nuclear Plant on June 9, 1985 NUREG-1154." Hugh L. Thompson Jr. was director – division of licensing for the Nuclear Regulatory Commission. July 26.

[20] FirstEnergy Nuclear Operating Company, 2002. Presentation slides to Nuclear Regulatory Commission, "Management and Human Performance Root Causes." August 15.

TVA to respond, under oath, whether these requirements were being met. TVA replied affirmatively on March 20, 1986, with a follow-up on June 5, 1986. In March 1988, NRC determined that the senior manager at TVA *"knowingly and willfully made a material false statement in his March 20, 1986, and his June 5, 1986, letters to the NRC regarding the meeting of the requirements of 10 CFR 50, Appendix B, at TVA's WBN* [Watts Bar nuclear]."[21]

Shearon Harris (NC): The NRC issued a construction permit in January 1978 and an operating license in January 1987.When construction began in 1978, the estimated cost for the four reactors planned at the site was $1.4 billion. Units 2, 3, and 4 were canceled in the early 1980s and Unit 1 went into operation at a cost of $3.9 billion.[22] The NRC's construction appraisal team inspection (CATI) identified two major problems: "*(1) lack of verification of piping and pipe support/restraint location to original design requirements and (2) lack of an ongoing program to effectively identify and resolve hardware clearance problems early in the construction process. Both of these concerns involve practices that could result in extensive inspection, analyses, and rework efforts very late in the construction schedule."*[23]

Palo Verde Unit 3 (AZ): The NRC issued a construction permit in May 1976 and an operating license in November 1987. For the past two years, the reactor has been rated by the NRC as the worst safety performers in the United States. The new managers, brought in to undo the damage that warranted that low rating, explained to the NRC Commissioners last July how the reactor got into that situation:

> *Our high plant performance combined with high performance assessments, although positive at the time, contributed to complacency and an environment that camouflaged our growing weakness in personal accountability and a higher tolerance for incomplete root cause analysis; encouraged an attitude of pride, reduced our focus on continuous improvement and established a mind set that we were good enough to handle all issues as they occurred.*[24]

[21] Nuclear Regulatory Commission Office of Investigations, 1988. "Report of Investigation – Watts Bar Nuclear Plant: Possible Willful Attempt by TVA Management to Mislead the NRC," Case No. 2-87-002S. October 11.
[22] United States Nuclear Regulatory Commission, "2006-2007 Information Digest," NUREG-1350 Vol. 18, August 2006; and Associated Press, April 14, 1988.
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Executive Summary

Findings and Recommendations in Brief

Global warming demands a profound transformation in the ways we generate and consume energy. Because nuclear power results in few global warming emissions, an increase in nuclear power could help reduce global warming—but it could also increase the threats to human safety and security. The risks include a massive release of radiation due to a power plant meltdown or terrorist attack, and the death of hundreds of thousands due to the detonation of a nuclear weapon made with materials obtained from a civilian nuclear power system. Minimizing these risks is simply pragmatic: nothing will affect the public acceptability of nuclear power as much as a serious nuclear accident, a terrorist strike on a reactor or spent fuel pool, or the terrorist detonation of a nuclear weapon made from stolen nuclear reactor materials.

The report finds that:

1. The United States has strong nuclear power safety standards, but serious safety problems continue to arise at U.S. nuclear power plants because the Nuclear Regulatory Commission (NRC) is not adequately enforcing the existing standards. The NRC's poor safety culture is the biggest barrier to consistently effective oversight, and Congress should require the NRC to bring in managers from outside the agency to rectify this problem.
2. While the United States has one of the world's most well-developed regulatory systems for protection of nuclear facilities against sabotage and attack, current security standards are inadequate to defend against credible threats. Congress should give the responsibility for identifying credible threats and ensuring that security is adequate to the Department of Homeland Security rather than the NRC.
3. The extent to which an expansion of nuclear power increases the risk that more nations or terrorists will acquire nuclear weapons depends largely on whether reprocessing is included in the fuel cycle, and whether uranium enrichment comes under effective international control. A global prohibition on reprocessing, and international ownership of all enrichment facilities, would greatly reduce these risks. The United States should reinstate a ban on reprocessing U.S. spent fuel and take the lead in forging an indefinite global moratorium on reprocessing. The administration should also pursue a regime to place all uranium enrichment facilities under international control.
4. Over the next 50 years, interim storage of spent fuel in dry casks is economically viable and secure, if hardened against attack. In the longer term, a geologic repository would provide the stability needed to isolate the spent fuel from the environment. It is critical to identify and overcome technical and political barriers to licensing a permanent repository, and the Department of Energy should identify and begin to characterize potential sites other than Yucca Mountain.
5. Of all the new reactor designs being seriously considered for deployment in the United States, only one—the Evolutionary Power Reactor—appears to have the potential to be significantly safer and more secure than today's reactors. To eliminate any financial incentives for reactor vendors to reduce safety margins, and to make safer reactors competitive in the United States, the NRC should require new U.S. reactors to be significantly safer than current reactors.
6. The proposed Global Nuclear Energy Partnership (GNEP) plan offers no waste disposal benefits and would increase the risks of nuclear proliferation and terrorism. It should be dropped.

Since its founding in 1969, the Union of Concerned Scientists (UCS) has worked to make nuclear power safer and more secure. We have long sought to minimize the risk that nations and terrorists would acquire nuclear weapons materials from nuclear power facilities. This report shows that nuclear power continues to pose serious risks that are unique among the energy options being considered for reducing global warming emissions. The future risks of nuclear energy will depend in large part on whether governments, industry, and international bodies undertake a serious effort to address these risks—including the steps outlined here—before plunging headlong into a rapid expansion of nuclear energy worldwide. In particular, the risks will increase—perhaps substantially—if reprocessing becomes part of the fuel cycle in the United States and expands worldwide.

The risks posed by climate change may turn out to be so grave that the United States and the world cannot afford to rule out nuclear power as a major contributor to addressing global warming. However, it may also turn out that nuclear power cannot be deployed worldwide on the scale needed to make a significant dent in emissions without resulting in unacceptably high safety and security risks. Resolving these questions is beyond the scope of this report, but the information provided here will help inform a necessary discussion of the risks of various energy technologies that can address global warming.

Global warming is a profound threat to both humanity and the natural world, and one of the most serious challenges humankind has ever faced. We are obligated by our fundamental responsibility to future generations and our shared role as stewards of this planet to confront climate change in an effective and timely manner. Scientists are acutely aware that the window for reducing global warming emissions to reasonably safe levels is closing quickly. Several recent analyses have concluded that, to avoid dangerous climate change, the United States and other industrialized nations will need to reduce emissions at least 80 percent by mid-century, compared with 2000 levels—and that national and international policies must be in place within the next 5 to 10 years to achieve this ambitious outcome.

Thus a profound transformation of the ways in which we generate and consume energy must begin now, and the urgency of this situation demands that we consider all possible options for minimizing climate change. However, in examining each option we must take into account its environmental and public health impacts, its potential impact on national and international security, the time required for deployment, and the costs.

Nuclear power plants do not produce global warming emissions when they operate, and the emissions associated with the nuclear fuel cycle and plant construction are quite modest (and will fall further if industry and transportation rely less on fossil fuels). Thus an expansion of nuclear power could help curb global warming. However, such an expansion could also worsen the threats to human safety and security from radioactive releases and wider access to materials that can be used to make nuclear weapons.

This report assesses the risks posed by nuclear power and proposes ways to minimize them. In particular, it considers (1) the risk of reactor accidents and how to improve government oversight of reactor safety; (2) the threat of sabotage and terrorist attacks on reactors and associated facilities, and how to improve security; (3) the potential for expanded nuclear power facilities to allow nations and terrorist groups to acquire nuclear weapons more easily, and what the United States can do to minimize those possibilities; and (4) how best to deal with the radioactive waste from U.S. power plants. This report also examines new designs for reactors and other nuclear power facilities, and considers to what extent these plants would entail fewer risks than today's designs.

Key Findings and Recommendations

1. Ensuring the Safety of Nuclear Power

The United States has strong nuclear power safety standards, but serious safety problems continue to arise at U.S. nuclear power plants because the Nuclear Regulatory Commission (NRC) is not adequately enforcing those standards.

Findings

Safety problems remain despite a lack of serious accidents.

A serious nuclear power accident has not occurred in the United States since 1979, when the Three Mile Island reactor in Pennsylvania experienced a partial core meltdown. However, the absence of serious accidents does not necessarily indicate that safety measures and oversight are adequate. Since 1979, there have been 35 instances in which individual reactors have shut down to restore safety standards, and the owner has taken a year or more to address dozens or even hundreds of equipment impairments that had accumulated over a period of years. The most recent such shutdown occurred in 2002. These year-plus closures indicate that the NRC has been doing a poor job of regulating the safety of power reactors. An effective regulator would be neither unaware nor passively tolerant of safety problems so extensive that a year or more is needed to fix them.

The most significant barrier to consistently effective NRC oversight is a poor "safety culture" at the agency itself.

The poor safety culture at the NRC manifests itself in several ways. The agency has failed to implement its own findings on how to avoid safety problems at U.S. reactors. It has failed to enforce its own regulations, with the result that safety problems have remained unresolved for years at reactors that have continued to operate. And it has inappropriately emphasized adhering to schedules rather than ensuring safety. A significant number of NRC staff members have reported feeling unable to raise safety concerns without fear of retaliation, and a large percentage of those staff members say they have suffered harassment or intimidation.

The NRC's recent curtailment of the public's right to participate in reactor licensing proceedings shuts the door to an important means of enhancing safety.

Public input has long played an important role in the NRC's process for licensing power plants. The NRC itself has identified numerous examples where public participation has improved safety. Despite this, the NRC recently removed the public's right to discovery and cross-examination during hearings on renewals of existing power plant licenses and applications for new ones, precluding meaningful public participation.

The NRC's policy on the safety of new reactors is an obstacle to ensuring better designs.

NRC policy stipulates that advanced reactors need provide only the same level of protection against accidents as today's generation of reactors, hampering the development of safer ones.

The NRC's budget is inadequate.

Congress continues to pressure the NRC to cut its budget, so it spends fewer resources on overseeing safety. The NRC does not have enough funding to fulfill its mandate to ensure safety while also responding to applications to extend the licenses of existing reactors and license new ones.

The Price-Anderson Act lessens incentives to improve safety.

The act, just renewed for another 20 years, severely limits the liability of owners for accidents at nuclear power plants. This protection lessens the financial incentives for reactor vendors to increase safety measures, and for owners to improve operating standards.

Recommendations

- To ensure that the NRC develops a strong safety culture as soon as possible and sustains it, Congress should require the NRC to bring in managers from outside the agency to establish such a culture, and evaluate them on whether they do so.
- The NRC should fully restore the public's right to discovery and cross-examination before and during hearings on changes to existing power plant licenses and applications for new ones.
- To ensure that any new nuclear plants are significantly safer than existing ones, the NRC should require that new reactors have features designed to prevent severe accidents, and to mitigate them if they occur. These design features should reduce reliance on operator interventions in the event of an accident, which are inherently less dependable than built-in measures.
- Congress should ensure that the NRC has enough resources to provide robust oversight of nuclear reactor safety, and to meet its goals for responding to requests from reactor owners in a timely manner without compromising safety.
- Congress should eliminate Price-Anderson liability protection—or substantially raise the liability limit—for new U.S. nuclear power plants, to remove financial disincentives for reactor designers and owners to improve safety.

2. Defending against Sabotage and Terrorist Attacks

While the United States has one of the world's most well-developed regulatory systems for protecting nuclear facilities against sabotage and attack, today's security standards are inadequate to defend against credible threats.

Findings

Sabotage of a nuclear reactor could result in a large release of radiation.

If a team of well-trained terrorists forcibly entered a nuclear power plant, it could disable safety systems within a matter of minutes, and do enough damage to cause a meltdown of the core, failure of the containment structure, and a large release of radiation. Such an attack could contaminate large regions for thousands of years, producing higher cancer rates and billions of dollars in associated costs.

Spent fuel pools are highly vulnerable to terrorist attack.

Unlike reactors, the pools used to store spent fuel at reactor sites are not protected by containment buildings, and thus are attractive targets for terrorist attacks. Such attacks could lead to the release of large amounts of dangerous radioactive materials into the environment.

The NRC gives less consideration to attacks and deliberate acts of sabotage than it does to accidents.

This lack of attention is manifested in emergency plans that do not take terrorist attacks into account, the agency's refusal to consider terrorist attacks as part of the environmental assessments during licensing proceedings, and its failure to adequately address the risk of an attack on spent fuel pools at reactor sites.

NRC assumptions about potential attackers are unrealistically modest.

The NRC's Design Basis Threat (DBT) defines the size and abilities of a group that might attack a nuclear facility, and against which an owner must be able to defend. Although not publicly available, before 9/11 the DBT was widely known to consist of three attackers armed with nothing more sophisticated than handheld automatic rifles, and working with a single insider whose role was limited to providing information about the facility and its defenses. The DBT has been upgraded post-9/11, but it still does not reflect real-world threats. For example, it excludes the possibility that terrorist groups would use rocket-propelled grenades—a weapon widely used by insurgents around the world.

The DBT is unduly influenced by industry perspectives and pressure.

The NRC would ideally base the DBT solely on plausible threats to nuclear facilities. However, in practice, the agency's desire to avoid imposing high security costs on the nuclear industry also affects its security requirements.

There is no assurance that reactors can be defended against terrorist attacks.

The NRC stages mock attacks to determine if plant owners can defend their reactors against DBT-level attacks. Test results reveal poor performance, and the integrity of the tests themselves is in question. The federal government is responsible for defending against attacks more severe than the DBT, but it has no mechanism for ensuring that it can provide such protection.

Recommendations

- The NRC should treat the risks of deliberate sabotage and attacks on par with the risks of accidents, and require all environmental reviews during licensing to consider such threats. The agency should also require and test emergency plans for defending against severe acts of sabotage and terrorist attacks as well as accidents.
- The NRC should require that spent fuel at reactor sites be moved from storage pools to dry casks when it has cooled enough to do so (within six years), and that dry casks be protected by earthen or gravel ramparts to minimize their vulnerability to terrorist attack.
- The Department of Homeland Security (DHS) should set the DBT. It should assess the credible threats to nuclear facilities, determine the level of security needed to protect against those threats, and assign responsibility for countering each type of threat to either industry or the federal government. To conduct its independent assessments, the DHS would need full-time staff with the necessary expertise. It would also need to address the internal problems that have hampered its past performance. The NRC would ensure that the nuclear industry complies with DHS requirements. The DHS should ensure that the government has enough resources to fulfill its responsibilities to protect nuclear facilities against credible threats as assigned by the DHS.
- The government should evaluate its ability to protect the public from attacks above the DBT level by periodically conducting tests that simulate an actual attack. The DHS should serve as an independent evaluator of such tests, analogous to the role performed by the Federal Emergency Management Agency during biennial exercises of emergency plans for nuclear plants.
- The government should establish a federally administered program for licensing private nuclear security guards that would require them to successfully complete a federally run training course and undergo periodic recertification.

3. Preventing Nuclear Proliferation and Nuclear Terrorism

The extent to which an expansion of nuclear power would raise the risk that more nations or terrorists will acquire nuclear weapons depends largely on two factors: whether reprocessing is included in the fuel cycle, and whether uranium enrichment comes under effective international control. A global prohibition on reprocessing, and international ownership of all enrichment facilities, would greatly reduce these risks.

Findings

An expansion of nuclear power could—but need not—make it more likely that more nations will acquire nuclear weapons. In any event, it is only one factor of many that will affect this outcome.

Many states that do not now have nuclear weapons already have the technical ability to produce them, should they decide to do so. In other countries without such a capability, nuclear power facilities could aid a nuclear weapons program—in some cases significantly. However, the political incentives for a nation to acquire nuclear weapons are the most significant factor, and there is little the United States or international community can do to prevent a determined nation from eventually acquiring such weapons.

The nuclear facilities that present the greatest proliferation risk are those that can be used to produce the materials needed to make nuclear weapons—plutonium and highly enriched uranium (HEU).

Reprocessing plants extract plutonium from used reactor fuel, while uranium enrichment facilities that make low-enriched uranium for reactor fuel can be used to make HEU.

An expansion of nuclear power could—but need not—make it more likely that terrorists will acquire nuclear weapons.

In any event, other sources of nuclear weapons and weapons materials exist. Because it is difficult and expensive to produce the fissile materials needed for nuclear weapons, terrorists are almost certainly unable to do so themselves. However, several countries have large military stockpiles of plutonium and HEU, or civil stockpiles of plutonium, which terrorists could steal and use to produce nuclear weapons. Terrorists could also steal a nuclear weapon, or purchase one that has been stolen.

The degree to which an expansion of nuclear power would increase the risk of nuclear terrorism depends largely on whether reprocessing is part of the fuel cycle—internationally or in the United States.

Reprocessing changes plutonium from a form in which it is highly radioactive and nearly impossible to steal to one in which it is not radioactive and could be stolen surreptitiously by an insider or taken by force during routine transportation. Building more facilities for reprocessing spent fuel and making plutonium-based reactor fuel would provide terrorists with more potential sources of plutonium, and perhaps with greater ease of access. U.S. nuclear power does not now pose a risk that terrorists will acquire material for nuclear weapons. However, the U.S. reprocessing program now being pursued by the administration would change that.

None of the proposed new reprocessing technologies would provide meaningful protection against nuclear terrorism or proliferation.

No reprocessing technology can be made as secure as directly disposing of used nuclear fuel.

Strict international controls on uranium enrichment facilities will be needed to minimize the proliferation risks associated with expanded nuclear power.

Such controls should not discriminate between nations that have nuclear weapons and those that do not.

Recommendations

- The United States should reinstate a ban on reprocessing U.S. spent fuel, and actively discourage other nations from pursuing reprocessing. The security risks associated with current and near-term reprocessing technologies are too great.
- The United States should take the lead in forging an indefinite global moratorium on operating existing reprocessing plants and building or starting up new ones. Reprocessing is not necessary for any current nuclear energy program, and the security risks associated with running reprocessing plants and stockpiling plutonium are unacceptable in today's threat environment, and are likely to remain so for the foreseeable future. A U.S. moratorium will facilitate a global moratorium.
- The administration should pursue a regime—overseen by the International Atomic Energy Agency—to internationalize all uranium enrichment facilities and to safeguard such facilities. To make such a regime attractive to nations without those facilities, it would need to be non-discriminatory, and thus cover all existing enrichment plants.

- The administration should work to complete a comprehensive Fissile Material Cutoff Treaty that prohibits the production of plutonium for any purpose—military or civil—and that institutionalizes and verifies the reprocessing moratorium.

4. Ensuring the Safe Disposal of Nuclear Waste

Over the next 50 years, interim storage of spent fuel in dry casks is economically viable and secure. However, identifying and overcoming the technical and political barriers to licensing a permanent U.S. geologic repository for nuclear waste is critical.

Findings

A permanent geologic repository is the preferred method for disposal of nuclear waste.

An underground geologic repository—if properly sited and constructed—can adequately protect the public and environment from radioactive waste for tens of thousands of years. However, a repository location must be chosen based on a high degree of scientific and technical consensus. Such a consensus does not now exist on the proposed Yucca Mountain facility in Nevada.

Reprocessing offers no advantages for nuclear waste disposal.

Reprocessing spent fuel to extract plutonium and uranium would not allow a geologic repository to accommodate more nuclear waste, as the repository would also have to accept high-level waste from reprocessing. Reprocessing would also increase the amount of material needing disposal in other engineered waste facilities.

There is no immediate need to begin operating a permanent repository.

Interim storage of spent fuel in dry casks at reactor sites hardened against attack is an economically viable and secure option for at least 50 years. However, such dry casks are not adequately protected today, and should be strengthened against attack, such as by surrounding them with an earthen berm.

Recommendations

- The United States should drop its plans to begin a reprocessing program.
- The federal government should take possession of spent fuel at reactor sites and upgrade the security of onsite storage facilities.
- Because licensing a permanent repository may take a decade or more, especially if Yucca Mountain is found unsuitable, the Department of Energy should identify and begin to characterize other potential sites.

5. Evaluating New Reactor Designs

Of all new reactor designs under consideration in the United States, at this time only one—the Evolutionary Power Reactor, which was designed to comply with more stringent European requirements—appears to have the potential to be significantly safer and more secure against attack than today's reactors. However, U.S. plant owners will have no financial incentive to build such reactors unless the NRC strengthens U.S. standards and requires that new reactors be significantly safer than today's reactors.

The administration's proposed Global Nuclear Energy Partnership (GNEP)—which would entail reprocessing U.S. spent fuel and building large numbers of new fast burner reactors to use plutonium-based fuel—offers no waste disposal benefits and would increase the risks of nuclear proliferation and terrorism.

Findings

Of all the new reactor designs, only one—the Evolutionary Power Reactor (EPR)—appears to have the potential to be significantly less vulnerable to severe accidents than today's reactors.

The Pebble Bed Modular Reactor has several attractive safety features, but outstanding safety issues must be resolved to determine whether it is likely to be safer than existing reactors. Other designs either offer no potential for significant safety improvements, or are too early in the design phase to allow informed judgment.

Of all the new reactor designs, only one—the EPR—appears to have the potential to be significantly less vulnerable to attack than today's reactors.

However, this may only remain the case if the NRC requires that new reactors be able to withstand the impact of a commercial aircraft, thus ensuring that U.S. EPRs will include the double containment structure that is part of EPRs built in Europe.

No technical fix—such as those incorporated in new reprocessing technologies—can remove the proliferation risks associated with nuclear fuel cycles that include reprocessing and the use of plutonium-based fuel.

Once separated from highly radioactive fission products, the plutonium is vulnerable to theft or diversion. New reprocessing technologies under consideration will leave the plutonium in a mixture with other elements, but these are not radioactive enough to provide theft resistance, and a nation seeking nuclear weapons could readily separate the plutonium from these elements by chemical means.

The proposed GNEP system of fast burner reactors will not result in more efficient use of waste repositories.

While the proposed GNEP system could, in principle, significantly reduce the amount of heat-producing actinides that would need disposal in a geologic repository, thus allowing it to accept more waste, this potential cannot be realized in practice. As the National Academy of Sciences and the U.S. Department of Energy have found, reducing the actinides by a meaningful amount would require operating a large system of nuclear facilities over a period of centuries, and cost hundreds of billions of dollars more than disposing of spent fuel directly.

Recommendations

- The NRC should require that new reactor designs be safer than existing reactors. Otherwise, designs with greater safety margins will lose out in the marketplace to designs that cut costs by reducing safety.
- Forthcoming NRC regulations that will require owners to integrate security measures into reactor designs if they are "practicable" should specify that the NRC—not reactor owners—will determine which measures meet that criterion.
- The NRC should require that new reactors be able to withstand the impact of a commercial aircraft.
- The United States should reinstate a ban on reprocessing U.S. spent fuel, and actively discourage other nations from pursuing reprocessing.
- The United States should eliminate its programs to develop and deploy fast reactors.

David A. Lochbaum

Experience Summary

10/96 to date *Nuclear Safety Engineer, Union of Concerned Scientists*

Responsible for directing UCS's nuclear safety program, for monitoring developments in the nuclear industry, for serving as the organization's spokesperson on nuclear safety issues, and for initiating action to correct safety concerns.

11/87 to 09/96 *Senior Consultant, Enercon Services, Inc.*

Responsible for developing the conceptual design package for the alternate decay heat removal system, for closing out partially implemented modifications, reducing the backlog of engineering items, and providing training on design and licensing bases issues at the Perry Nuclear Power Plant.

Responsible for developing a topical report on the station blackout licensing bases for the Connecticut Yankee plant.

Responsible for vertical slice assessment of the spent fuel pit cooling system and for confirmation of licensing commitment implementation at the Salem Generating Station.

Responsible for developing the primary containment isolation devices design basis document, reviewing the emergency diesel generators design basis document, resolving design document open items, and updating design basis documents for the James A. FitzPatrick Nuclear Power Plant.

Responsible for the design review of balance of plant systems and generating engineering calculations to support the Power Uprate Program for the Susquehanna Steam Electric Station.

Responsible for developing the reactor engineer training program, revising reactor engineering technical and surveillance procedures and providing power manuevering recommendations at the Hope Creek Generating Station.

Responsible for supporting the lead BWR/6 Technical Specification Improvement Program and preparing licensing submittals for the Grand Gulf Nuclear Station.

03/87 to 08/87 *System Engineer, General Technical Services*

Responsible for reviewing the design of the condensate, feedwater and raw service systems for safe shutdown and restart capabilities for the Browns Ferry Nuclear Plant.

08/83 to 02/87 *Senior Engineer, Enercon Services, Inc.*

Responsible for performing startup and surveillance testing, developing core monitoring software, developing the reactor engineer training program, and supervising the reactor engineers and Shift Technical Advisors at the Grand Gulf Nuclear Station.

Experience Summary (continued)

10/81 to 08/83 *Reactor Engineer / Shift Technical Advisor, Tennessee Valley Authority*

Responsible for performing core management functions, administering the nuclear engineer training program, maintaining ASME Section XI program for the core spray and CRD systems, and covering STA shifts at the Browns Ferry Nuclear Plant.

06/81 to 10/81 *BWR Instructor, General Electric Company*

Responsible for developing administrative procedures for the Independent Safety Engineering Group (ISEG) at the Grand Gulf Nuclear Station.

01/80 to 06/81 *Reactor Engineer / Shift Technical Advisor, Tennessee Valley Authority*

Responsible for directing refueling floor activities, performing core management functions, maintaining ASME Section XI program for the RHR system, providing power maneuvering recommendations and covering STA shifts at the Browns Ferry Nuclear Plant.

06/79 to 12/79 *Junior Engineer, Georgia Power Company*

Responsible for completing pre-operational testing of the radwaste solidification systems and developing design change packages for modifications to the liquid radwaste systems at the Edwin I. Hatch Nuclear Plant.

Education

June 1979 Bachelor of Science in Nuclear Engineering, The University of Tennessee at Knoxville

May 1980 Certification, Interim Shift Technical Advisor, TVA Browns Ferry Nuclear Plant

April 1982 Certification, Shift Technical Advisor, TVA Browns Ferry Nuclear Plant

Professional Affiliations

Member, American Nuclear Society (since 1978).

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